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MINERAL CHEMISTRY OF AMPHIBOLES FROM JALOR RING STRUCTURE, RAJASTHAN

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ABSTRACT

The paper describes for the first time the mineral chemical data for the amphiboles of the Jalor granites, Rajasthan, The amphiboles belong to the composition of Ferro-hornblende, Ferro-edenitic tschermakite and Ferro-hornblende tschermakite. The chemical trend of Jalor magma was caused by the late stage influx of fluids derived from the Siwana magma.

INTRODUCTION

The Trans-Aravalli Block is unique in the geological evolution of the Indian Shield, as it marks a major period of anorogenic (A-type), 'within-plate' magmatism represented by the Malani igneous suite of rocks. The late Proterozoic, trans- Aravalli, Malani igneous suite of rocks (55,000 Km², 750 Ma) comprising peralkaline (Siwana), peraluminous or mildly peralkaline (Jalor) and acid volcanics (welded tuff, rhyolite, trachyte, explosion breccia and perlite) are characterised by volcano-plutonic ring-structure and radial dykes. The suite is bimodal in nature with minor amount of basalt, gabbro and dolerite dykes. Based on the field work, trace elements such as Ba, Th, U, Ga, Y, Zr and Ga/Al including rare earth elements (Dhar, 1990, Kochhar and Dhar, 1993, Kochhar et al 1995), confirmed the peralkaline component in the dominant peraluminous Jalor magma. In this paper the mineral chemical data obtained for amphiboles from peralkaline and peraluminous Jalor granites is described so as to ascertain their evolutionary trends.

MINERAL CHEMISTRY METHODOLOGY

The chemical analyses were performed on automatic electron microprobe at the Mineralogical Laboratory, University of Bern, Switzerland. The elements Si, Al, Fe, Mg, Ca, Na, K, Ti, Mn were determined using natural silicates and oxides as standards. The calculations were carried out on the basis of 13(O). The classification and nomenclature of amphiboles follow recommendation of IMA (1978) scheme. A total of 5 amphibole analyses (3 peralkaline granite and 2 peraluminous granite) were determined. For

peralkaline granites 13 analyses data were obtained on amphiboles, whereas for peraluminous granite 9 analyses data were obtained.

PETROGRAPHY

The peraluminous granite of Jalor area are pink and white in colour which contain alkali feldspars (perthite and orthoclase) which is mostly altered to sericite, plagioclase, quartz (high quartz and subhedral-anhedral varieity) and ferro-magnesians include hornblende and biotite found intergrown with each relationship. The peralkaline granites occur as sheets within the dominant peraluminous granite. It is identified in the field by its bluish tinge. Orthoclase and perthite are by far the dominant feldspars followed by quartz again (high quartz subhedral anhedral variety). Amphibole is by and large ferro-hornblende showing a conspicous compositional variation and reaction relationship with pleochroism X=light greenish yellow, Y=yellowish green and Z=bluish green. The rims of the amphibole grains are dark green coloured and the cores somewhat light green coloured. Biotite, which is annite rich is often broken down to iron-oxide.

MINERAL CHEMISTRY

The mineral chemical data of amphiboles from peralkaline granite (J18) and peraluminous granite (J17) are given in table 1 In the peraluminous granite (A.I.<1), there is an enrichment of elements such as Na, K, Mg, Ca from core to rim, whereas Fe and Al show a decreasing trend. In the peralkaline granite (A.I.>1) the elements such as Na, K, Mg, Ca decrease from core to rim and Fe and Al shows an increasing trend. It is noteworthy that Fe contents of Jalor amphiboles are quite high. According to Leake (1978), the amphiboles can be classified as calcic amphiboles if (Ca+Na)B>1.34, NaB<0.67 and (Na+K)A is usually <0.50. Majority of the samples analysed have (Na+K)A<0.50 and (Ca+Na)B>1.34 and on the plot Si versus Mg/(Mg+Fe^{2+}) they fall in the field of ferrohornblende and one composition falls in the field of ferro-tschermakitic hornblende (Fig.1). Two compostions have (Na+K)A>0.50 and as such correspond to the edenitic composition. The compositions of peralkaline granite have slightly higher silica content and follow trend as proposed by Giret et al (1980), Fe^{3+} == Aliv == Fe^{2+} + Si. This process is however a late stage phenomena observed in the high Si compostions. Plot of Si versus Na in X site for the Jalor granites show that amphiboles plot in the ferro-hornblende and ferro-edenitic fields, amphiboles from adjacent peralkaline (Al>1) Siwana granite (Baskar, 1992) plot in the alkali amphibole group. Field of amphiboles from Seychelles granite (pink and grey variety), (Hoshino, 1986) is also shown for comparison, Fig.2. The calcic-amphibole compostion of the Jalor granite seem to be governed mainly by MgY == Fe^{2+}Y

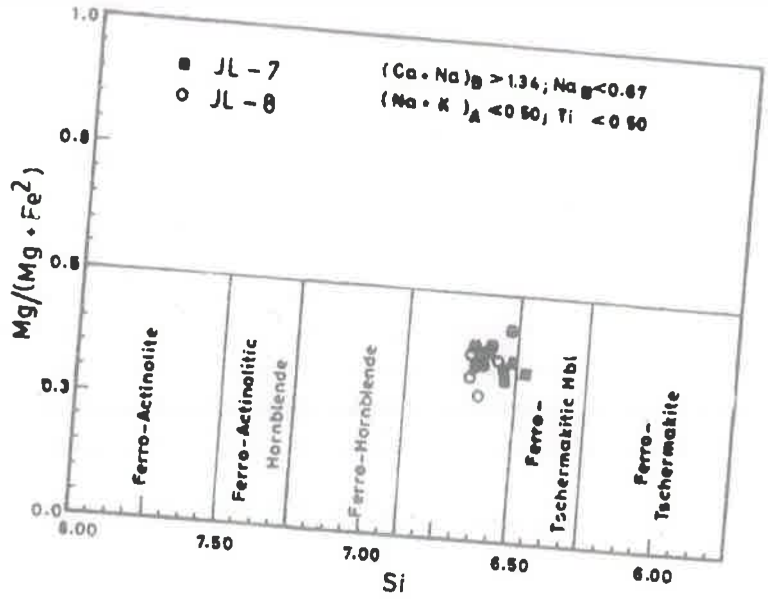

Fig. 1. Si versus $Mg(Mg+Fe^{2+})$ plot for Jalor Amphiboles

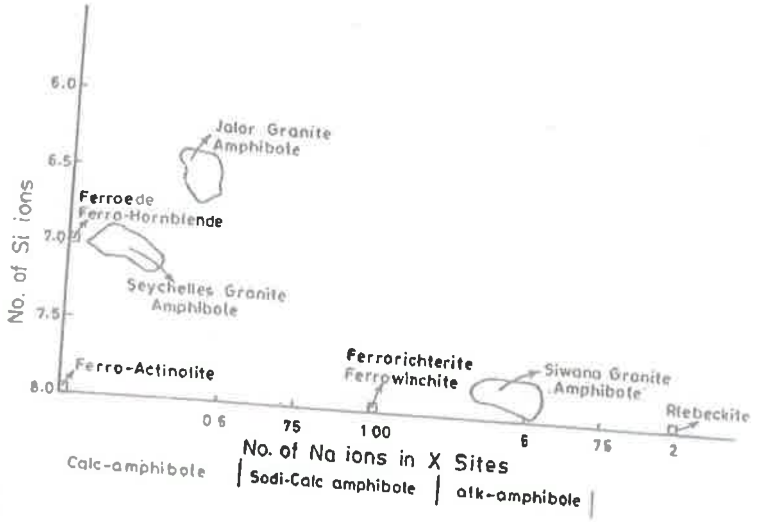

Fig. 2. Si versus Na in X site per fermula unit of the Jalor Amphiboles

Table. 1. Mineral Chemistry of Jolar Amphiboles

Rock	J18(1)					J18(2)					J18(3)		
	1	2	3	4	5	1	2	3	4	5	1	2	3
SiO_2	42.88	42.66	42.76	42.34	42.14	43.44	43.24	43.29	42.73	42.22	43.40	43.47	42.96
Al_2O_3	7.86	7.86	7.78	7.71	7.33	7.50	7.73	7.94	7.93	7.93	7.77	7.79	7.79
FeOt	26.44	26.09	28.16	28.95	27.98	26.35	25.69	26.36	27.65	28.72	25.79	26.03	27.40
MgO	5.74	5.74	5.09	4.21	4.01	5.55	6.02	5.76	4.74	3.98	5.95	5.49	5.05
CaO	10.03	9.93	9.80	9.62	9.91	10.12	10.21	10.08	9.80	9.86	10.24	10.24	10.18
Na_2O	2.12	2.06	1.95	1.93	1.89	2.00	1.93	1.97	2.02	1.97	2.00	1.98	1.98
K_2O	1.05	1.06	0.94	0.97	0.99	0.96	1.06	1.06	0.99	1.08	1.11	1.07	1.03
TiO_2	1.68	1.85	1.52	1.10	1.05	1.66	1.67	1.82	1.35	1.11	1.81	1.82	1.64
MnO	0.46	0.46	0.70	0.71	0.71	0.44	0.32	0.31	0.75	0.73	0.40	0.45	0.49
TOTAL	98.25	97.69	98.70	97.54	96.01	98.01	97.87	98.58	97.95	97.60	98.47	98.33	98.51
Si	6.539	6.537	6.463	6.511	6.620	6.648	6.622	6.586	6.522	6.517	6.608	6.640	6.566
Al	1.415	1.420	1.387	1.399	1.358	1.354	1.396	1.425	1.428	1.444	1.396	1.403	1.404
Fe^{+3}	1.251	1.239	1.774	1.760	1.422	1.098	1.016	1.077	1.609	1.584	1.033	0.983	1.222
Fe^{+2}	2.120	2.103	1.784	1.961	2.252	2.272	2.272	2.275	1.918	2.122	2.348	2.340	2.279
Mg	1.305	1.311	1.148	0.965	0.940	1.266	1.376	1.307	1.078	0.917	1.351	1.250	1.152
Ca	1.639	1.630	1.587	1.584	1.668	1.659	1.675	1.643	1.602	1.630	1.670	1.676	1.666
Na	0.627	0.611	0.572	0.575	0.576	0.593	0.569	0.580	0.598	0.591	0.590	0.587	0.585
K	0.203	0.206	0.181	0.191	0.198	0.187	0.207	0.205	0.193	0.212	0.216	0.208	0.201
Ti	0.193	0.214	0.173	0.127	0.124	0.191	0.193	0.208	0.155	0.129	0.208	0.209	0.188
Mn	0.178	0.178	0.271	0.277	0.284	0.171	0.126	0.121	0.290	0.287	0.155	0.174	0.190
Na(B)	0.361	0.370	0.413	0.416	0.332	0.341	0.325	0.357	0.398	0.370	0.330	0.324	0.334
NaK(A)	0.469	0.447	0.340	0.351	0.442	0.439	0.451	0.428	0.393	0.433	0.476	0.471	0.453
Al(vi)	0.000	0.000	0.000	0.000	0.000	0.001	0.018	0.011	0.000	0.000	0.004	0.043	0.000
Mg/Fe	0.381	0.384	0.392	0.330	0.294	0.358	0.377	0.365	0.360	0.302	0.375	0.348	0.336

1(core) ----> to 5(nm)

Table. 1. Mineral Chemistry of Jolar Amphiboles (Contd.)

Rock	J17(1)				J17(2)				
	1	2	3	4	1	2	3	4	5
SiO_2	43.50	43.41	43.12	43.84	43.56	43.66	43.43	43.40	44.20
Al_2O_3	7.42	7.71	7.94	7.57	7.59	7.41	7.33	7.35	7.08
FeOt	27.60	26.92	26.17	26.13	26.72	26.69	28.37	28.79	28.95
MgO	4.87	4.93	5.19	5.54	5.33	5.50	4.80	4.84	4.95
CaO	10.08	10.05	10.09	10.39	10.02	9.83	9.84	9.78	9.61
Na_2O	1.98	2.11	2.10	2.10	2.08	2.04	1.99	2.00	1.94
K_2O	0.99	1.06	1.03	1.03	1.03	0.94	0.94	0.93	0.91
TiO_2	0.82	1.74	1.86	1.42	1.52	1.34	0.52	0.50	0.17
MnO	0.69	0.60	0.60	0.65	0.60	0.65	0.72	0.89	1.00
TOTAL	**97.96**	**98.54**	**98.25**	**98.68**	**98.44**	**98.07**	**97.94**	**98.48**	**98.81**
Si	6.656	6.624	6.593	6.657	6.626	6.633	6.629	6.561	6.619
Al	1.339	1.388	1.432	1.356	1.362	1.328	1.320	1.312	1.251
Fe^{+3}	1.439	1.159	1.096	1.143	1.267	1.451	1.687	1.972	2.162
Fe^{+2}	2.098	2.273	2.248	2.174	2.131	1.937	1.932	1.666	1.462
Mg	1.111	1.122	1.184	1.255	1.210	1.246	1.093	1.091	1.105
Ca	1.653	1.643	1.652	1.690	1.634	1.599	1.609	1.584	1.541
Na	0.587	0.625	0.651	0.617	0.613	0.601	0.589	0.586	0.564
K	0.193	0.206	0.212	0.200	0.199	0.185	0.183	0.179	0.174
Ti	0.094	0.200	0.214	0.163	0.174	0.153	0.060	0.057	0.019
Mn	0.269	0.233	0.232	0.252	0.231	0.252	0.280	0.341	0.382
Na(B)	0.347	0.357	0.348	0.310	0.366	0.401	0.391	0.416	0.459
NaK(A)	0.433	0.473	0.515	0.508	0.445	0.386	0.381	0.349	0.279
Al(vi)	0.000	0.110	0.025	0.013	0.000	0.000	0.000	0.000	0.000
Mg/Fe	0.346	0.331	0.345	0.366	0.362	0.391	0.361	0.396	0.430

1(core) ----> to 5(nm)

and AlZ+CaX == SiZ+NaX. The former substitution seems to be applicable in the ferro-hornblende compostion whereas the later seems to be applicable in the ferro-tschermakitic hornblende and ferro-edenitic compostion and belong to solid-solution series of hastingite-ferroedenite-borrosite involving substitution Na Al^{iv} == Si and Ca Fe^{2+} == NaFe^{3+} (c.f.Fabries, 1978) and which leads to oxidation and reduction of Ca and Al contents at the expense of Si.

Mantle derived F rich fluids carrying Na, Li, Fe, Sr, U and Th (Kochhar and Dhar 1993, Kochhar et al 1985, c.f. Bohin 1988) from the adjoining Siwana magma caused the peralkaline signatures on the predominant peraluminous Jalor granite and contributed to the development of ferro-edenite in the amphiboles. More work is needed to understand the evolutionary trends of the amphiboles in the Jalor granite in relation to the peraluminous peralkaline co-existence.

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